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**Geo-Spatial Data Accuracy and its Legal Implications in the
Malaysian Context^{*}**

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GEO-SPATIAL DATA ACCURACY AND ITS LEGAL IMPLICATIONS IN THE MALAYSIAN CONTEXT

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Abstract

The progress or expansion of GIS users in Malaysia has brought the question of integrity and quality of spatial data to the forefront and hence on the appropriate management of the data. Issues of liability from harm resulting from the use, misuse and inappropriate uses of the data and information as well as from decisions arrived from inaccurate data is therefore inevitable. The writers, after determining the meaning and the need for geospatial data accuracy, will reflect on the law and standards pertaining to data accuracy and its legal implication due to the lack of accuracy by tracing the source or basis of data inaccuracy i.e. primary data source, processing of the data and the human factor.

INTRODUCTION

GIS was first introduced in Malaysia about a decade ago. Amongst the major issues that arise, was the absence or lack of digital geospatial data. GIS users then, need to digitise their own data from hardcopy maps or survey plans to convert them to digital data. This conversion was certainly time-consuming and expensive, so much so, that accuracy of data was not of paramount importance. At present, with the realisation of GIS as a tool capable of storing massive data, manipulating, displaying and querying, modelling, visualisation applicable to multiple discipline, lead to a rapid demand for GIS data and spatial data. The producer and supplier of these data is no longer restricted to the Department of Survey and Mapping Malaysia as the government agency for mapping, but GIS users can now obtain digital geospatial data from other government agencies such as the Agriculture Department, Local Government Authority, Department of Director-General of Lands and Mine as well as commercial data suppliers and geographic service providers. Consequently, the problems today are caused more by the increasing availability of digital geospatial data rather than the absence or lack of them.

Due to the scores of available data, users are in a dilemma as to which data to access and relevant to their needs. Very often, users are simply unaware of the types of data that are in existence and its location. To add to their predicament, with the numerous data providers, the users also have to choose from which acceptable or correct source to access and use, as data may be available from different sources. Disparate data from these sources, though could be integrated, are usually incompatible in terms of storage format, map projection, map scale, symbols, accuracy, and other cartographic specifications. These data therefore need to be evaluated and most often converted. Hence the question of merits of the data came into being.

Users' perception of GIS data has been positive as they generally believe that it is accurate and reliable. The users of GIS data in Malaysia can be categorised into four broad groups, namely, the experts in GIS, the moderate users, the less expert users, and the non-expert users. This can be studied from the group of users and the stages of data life cycle which could contribute to the inaccuracy of data. The non expert users are often impressed by the beguiling attractiveness and the high aesthetic quality of cartographic products from GIS so much so the accuracy of data is not of much concern. This group of users usually use GIS to display graphics for reports. Although many have use GIS, they however, seldom question the accuracy and reliability of this data. Matters such as the map scale in use, the map projection adopted, and above all, the reliability of the base map from which the map is derived were not often broached. While not realising these factors can affect their decisions, users interpret the information in GIS data according to whatever knowledge and

experience they possessed. On the other hand, expert users such as the land surveyors, due to the nature of their profession, emphasises the need for the data to be precise, accurate, relevant and complete. GIS professionals that undergo formal education in GIS both locally and especially from abroad by now know the difference between GI System and GI Science. However many professionals from other disciplines still maintain GIS as a tool for decision making, although some may now know how to use GIS to do prediction or to model their alternative solutions. Unfortunately these professionals have little or no knowledge of map making and surveying and hence fail to assess the quality of the data used. Moreover, their exposure to GIS is limited to short term training or courses on GIS which are inadequate in content. It can be summarised that Malaysians, except for professionals whose job requires the use of maps, are mostly not accustomed to map reading in their daily activities. Therefore it is understandable that users may not be aware of the accuracy of GIS data.

GEOSPATIAL DATA PRODUCTION

Data Life Cycle

It is observed that changes that occur during the data life cycle (Figure 1) may affect data accuracy. As has been pointed out by Russell G, Congalton,H, Todd Morer in their book Quantifying Spatial Uncertainty in Natural Resources : Theory & Application for GIS and Remote Sensing, (2000), common occurrence of changes of data in its life cycle are:

- during observation;
- during interpretation of observations, eg interpretation of vegetation boundaries on air photographs which creates linear entities;
- during digitization eg replacement of a smooth, analogue line on a map with a polyline in GIS database
- during resampling associated with projection change or change of spatial resolution: generalization of data; &
- during assembly of results in support of decision or for archiving

In addition to the occurrence of changes during the data life cycle which may affect data quality, the following circumstances show instances when inaccuracy comes about. Geometric incompatibility occur when digital geospatial data captured from different map sheets or obtained from different sources fail to match. This may be due to changes to the geo-referencing standards in which new datum replaces old datum. These problems frequently occur during the transitional period when geospatial data referenced to original datum and new datum are in concurrent use.

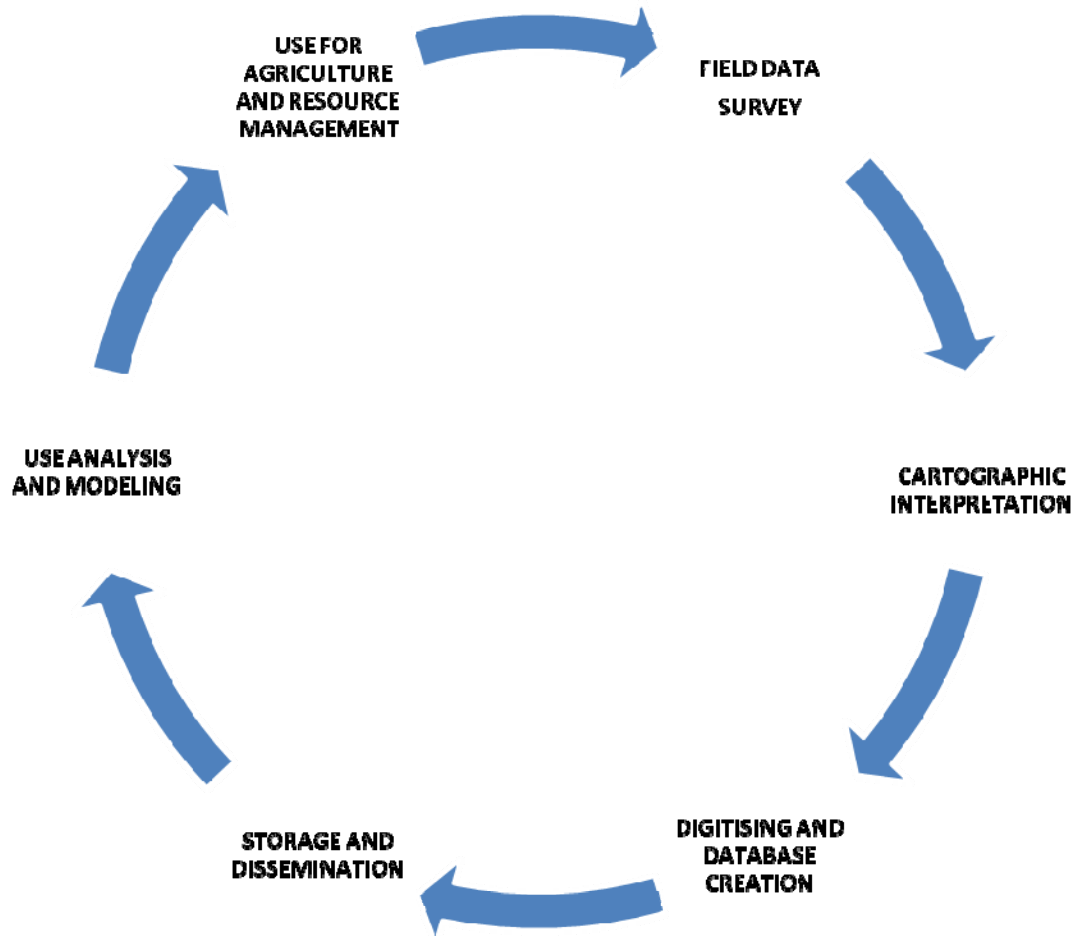


FIGURE 1

Uncertainty exist in every phase of the life cycle of geospatial data

Another instance where inaccuracy occurs is during the data collection stage where geospatial data is collected at different scales and with different map projections. National small-scale (1: 750 000 and 1: 500 000) and medium scale (1:50 000) maps were based on the cylindrical Rectified Skew Orthomorphic projection. On the other hand, large scale cadastral maps (1: 5 000) is based on the rectangular grids of the Cassini Soldner projection. Data inaccuracy may also occur even when similar map projection and similar scale were used as the maps are produced by different agencies for different purposes at different times. It requires reconciliation of mismatching features across map boundaries which is clearly not a trivial task requiring human decisions to apply logic to resolve the problem. Another common phenomenon that causes data inaccuracy is the quality degradation due to time. Although data collection and digitising are carried out using relatively stringent specifications as a rule, the same level of requirements is not always enforced when digital databases are updated. This has resulted in the degradation of geometric accuracy in the contents of the database. It also tends to invalidate the data quality information attached to the metadata of the data sets concerned.

Quality is also degraded when digital databases are not maintained properly. Ideally, a geo-database is a faithful snapshot of the status of human activities and natural features that are found at a particular geographic area of interest at a specific point in time. When these features or activities change, the database must also be updated accordingly. This requires continuous monitoring of human activities and the natural environment in order to check all the changes that have occurred. When such database is not updated, it will lead to serious uncertainties when data is used for time-sensitive spatial problem solving.

Data Producers/ Providers

In Malaysia, geospatial data producers could be conveniently categorised into two, i.e. government and private sector data producers. Most, if not all of these producers rely on the Department of Survey & Mapping Malaysia's (widely known by its Malay acronym JUPEM) cadastral parcel fabric or topographic data as the base data to collect and produce their own geospatial information. At national level, a committee known as the National Malaysian Spatial Data Committee (formerly called the National Mapping Committee) was formed to coordinate the data acquisition activities of these government geospatial data producers. Related issues of data acquisition and production, including addressing the needs of members and data quality were worked upon by the various sub-committees formed under it. The activities of geospatial data producers in the private sector were however left uncoordinated and not very much controlled except for the conduct of cadastral surveys and production of cadastral survey data. Information on their activities are only known in two circumstances, i.e. when application is made to JUPEM to collect data and when those acquired data were submitted to JUPEM to obtain clearance for geospatial information production. Unlike in the case of cadastral data, vetting of other geospatial data by JUPEM only involves the filtering of security sensitive information, and not quality or more specifically accuracy inspection.

JUPEM remains inarguably the major producer and provider of geospatial data in Malaysia. It retains ownership over those data in the form of copyright over its product. Nevertheless, data ownership has brought about issues of legal liability founded on the "harm-based concept" in which harm or injury incurred as a result of errors or shortcomings or incorrect decision could well be due to data inaccuracy. In this instant, in determining the liability of parties involved in the handling of geographic information, i.e. from the original data providers/producers, software producers, secondary producers and finally the users, the law will look at those in the information chain and consider whether they have exercised appropriate standard of duty to prevent the occurrence of the damages. The law that is applicable to ascertain liability is the law of contract and tort. However, there is no specific legislation on the matter. JUPEM had in the past provided disclaimers exempting them from liability, on its printed maps and recently, on its digital map products; however, other government agencies had varied practices pertaining to this matter. Although there had not been any known litigation against them, all currently acknowledged the fact that users are getting more sophisticated and increasingly aware of their rights and as such many had taken steps to protect themselves in the eventuality of providing inaccurate data to their clients.

However, the liability in geospatial products and services relating to computerised geographic information systems is difficult to determine by traditional legal theory. This is because of the wide array of current as well as potential application of geographic information technologies. Each application requires integration of information specific to the application and often will involve different attributes, analytical method, spatial features and accuracy requirements.

Other legal issues that has to be tackled by JUPEM and other data providers should include identifying duties which are mandatory as data providers regarding the quality of data; duties that every professional is expected to do (Bedard, Devillers, Gervais & Jean-soulin, 2004). Among these duties are the responsibilities of informing users about the datasets, that not only provide users with

information pertaining to the content of the data but the limitation or defect or potential risk in the data utilisation. In other words, the data producers need also consider users' intended usage of the data and warn them accordingly. These legal obligation or ethical requisite may be provided under the code of conduct as provided by the Licensed Land Surveyors Act 1958 (Revised 1991) or the consumer protection legislations.

DATA ACCURACY

The standards of data accuracy vary from one producer to the other, and may be very significantly different due to the fact that their production serves differing purposes. In the case of JUPEM, their town and city maps are produced at scales ranging from 1: 1250 to 1: 10 000; the planimetric accuracy of these maps range respectively from 0.6m to 5.0m. Additionally, topographic maps are produced at scales of 1: 25 000 and 1: 50 000 and their planimetric accuracies are 12.5m and 25.0m respectively. On the other hand, the height accuracies would be at half the contour intervals depicted on those maps.

Another source of geospatial data produced by JUPEM is the cadastral survey database. The database was originally developed through the keying-in of bearing and distance values appearing on certified plans, which were derived from actual ground surveys. These cadastral surveys vary in accuracies as they were performed previously under three different categories or classes, according to the needs of meeting the required level of accuracies; for instance surveys in town areas would need to achieve higher than 10cm level of accuracy, whereas in the countryside accuracy of 50cm is considered adequate. Currently, geospatial data produced from the conduct of cadastral surveys evidently were the most accurate and as such were relied upon to serve as base data for geospatial data production by others. With the most dependable accuracy attribute, it also served as one of the core datasets of the nation's spatial data infrastructure.

Beginning 2006, the development of the National Utility Database was started by JUPEM, whereby data on the location of underground utilities such as gas, water and sewage pipelines as well as telecommunication and electric cables were captured and stored in the said database. Those data were initially sourced from the utility providers and due to the differing reliability of the information provided, they had to be segregated into four quality levels, i.e. Quality Levels (QL) A to D, with QL A being the highest level in terms of accuracy, with ± 10 cm planimetric and height (depth) accuracies.

Other governmental producers of geospatial data such as the Departments of Agriculture, Mineral and Geoscience, Planning, Forestry etc., have their own accuracy criteria to meet their needs and specifications but is clearly not as demanding as that of JUPEM.

Apparently, the need for high accuracy geospatial data is most evident in the case of underground utility data production and use. It would be obvious that erroneous data can lead to erratic digging in the course of emplacing new facilities and this could further cause accidents resulting in extensive damages, including the loss of lives. The need for highly accurate cadastral surveys too has been recognised as being imperative and given a lot of emphasis in the past. As such, concerned surveys have been traditionally very tightly regulated and this has resulted in a reliable cadastral survey system that underpins the highly progressive land market of Malaysia.

Geospatial data accuracy specifications or statements were in the past not given much attention. Nevertheless, over the last decade or so, demands have been made by users for data producers to publish quality or at least accuracy statements for their data. JUPEM has responded to this call by publishing data accuracy statements in the metadata published through their on-line JUPEM Geoportal (a dedicated departmental website to provide on-line sales of data and services to users).

Efforts to standardise the measure of data quality (including data accuracy) and publishing them had been initiated over the last few years. JUPEM has taken the lead in this effort, whereby the task of determining data quality through field measurements and verification had been conducted for the map sheets that they had produced. This form of verification, albeit laborious, is deemed necessary and the outcome of this quality check is published in the metadata produced by the department. JUPEM had also been engaged in developing the data quality standards which would eventually be utilised by all geospatial data producers.

LEGAL IMPLICATION FROM DATA INACCURACY

Malaysian is a non-litigious society. There is no known legal suit pertaining to injuries or damages arising from data inaccuracy. However, court cases with regard to damages suffered as a result of data inaccuracy, in developed countries where GIS originated are on the rise. Issues of liability as a result of loss of earnings, opportunities, property and even life gave rise to questions of ownership or authorship which have become more uncertain as data can be easily manipulated and mixed with data from other sources, sometimes of unknown lineage and perhaps at inappropriate scale. Liability has been shown to possibly arise from inaccurate, incomplete and misleading information of data as well as incorrect decisions. The first indications that there are serious problems with the data are when accidents take place.(Cho, 2005)

It has to be noted that on the international front, Malaysia had on two occasions appeared in the International Court of Justice in disputes with her neighbours, Indonesia, over the islands of Ligitan and Sipadan, and with Singapore, over Pedra Branca. Amongst a multitude of factors put forth in the arguments, aspect of data inaccuracies was also hinged upon in both of the aforementioned cases.

Pertaining to the issue of Ligitan and Sipadan, the depiction of erroneous data on old maps produced by Malaysia has been used against them by their adversary. In this case, the portraying of the extended parallel of latitude 4°10' N which protrudes the island of Sebatik on the eastern side of the whole contentious area, when in fact the line should have stopped at the easternmost corner of Sebatik, has been used by Indonesia to argue that the islands of Ligitan and Sipadan were their rightful possession as the concerned British-Dutch Boundary Convention of 1891 stated that geographical entities south of the latitude would be territorially Dutch (later inherited by Indonesia) and north of it, British (subsequently inherited by Malaysia). Ironically, synonymous depiction of erroneous information on old maps produced by Malaysia, showing the island of Pedra Branca with the lighthouse symbol together with the annotation "Singapore", has been argued to indicate that Malaysia recognizes the island to be Singapore-owned, albeit Malaysia insisted that the annotation is just to indicate that only the lighthouse is operated and owned by Singapore.

Since there are no court cases from Malaysia to illustrate the damages or injury that occur owing to data inaccuracy, the following cases from USA and Australia are referred to indicate the legal implication as a result of error in maps, that can be fatal:

Case 1

According to a report in the US journal Point of Beginning as cited by the Asian Surveying and Mapping (11 March 2009), mistakes by surveyors in Texas are being blamed for millions of dollar losses suffered by local landholders as a result of flooding in the aftermath of Hurricane Ike, the third most destructive hurricane in the USA. Some of the damage in the US was due to flooding, where housing had been built below the Base Flood Level. This is a contour defined by the Federal Emergency Management Agency to correspond to a 100 year flood level. The position of the Base Flood Level was fixed by the National Geodetic Survey long ago and marked by concrete and brass monuments. In the 1980's the Federal Emergency Management Agency (FEMA) re-measured the

contour and found that the flood plain was about a metre above the old marks. It issued a new map that became the document of reference for insurance companies and other authorities. However, the surveyors continued to rely on the old elevations. As a result of the mistake made by the surveyors, 20 homes near the town of LaBelle were built in the flood plain as people who thought their new homes were being built above flood level were actually building a metre below it. To add to the homeowners' nightmare, they had no flood insurance and FEMA would not permit them to rebuild their homes because they were in the flood plain.

Case 2

Four New South Wales, National Parks & Wildlife Service (NPWS) officers were killed from smoke suffocation in a burn-off operation. The officers were given maps that showed two possible escape routes, but which ended in impenetrable bush or line of cliffs. The Senior Deputy State Coroner informed the court that there were deficiencies in the maps used in the operations as information contained in the map issued by NPWS showed a cleared hilltop, which potentially could have provided shelter from the fire. Unfortunately, the map did not show a 30m cliff which stood between the anyone trying to escape the fire and the cleared area. The map also showed a path known as Wallaby Track running directly towards a local motorway. In reality this path twists into impenetrable bush. It was found by the court that the original botanical map had not been ground-truthed to include specific details and did not mark areas with safe refuges to retreat to as required in the fire management procedures guidelines (Cho. 2005)

The above two cases demonstrate the classic issues of standards to be attained if liability is to be avoided. The duty to take care, the responsibility of due diligence to those who may be affected by a lack of care, the reliance on information to one's detriment, and the subsequent injury, damage and loss that occurs, are established legal standards. Such standards are set either by statutory mandates or through the common law. In Malaysia, however, there's no statutory mandate in order to ensure compliance. However, the common law of tort may be applicable in failure to meet the required standard of care by the profession.

CONCLUSION

The rapid growth of GIS users in Malaysia has raised the need for data accuracy and the appropriate management of these data. There is no specific law concerning data quality, and no consistent legal framework on the management of GIS or geospatial data; what exists is simply a patchwork of self regulation in the form of government circulars and statutes. It is thus important that Malaysia have a codified policy on managing geospatial data as the country moves towards a spatially enabled government. This will enable relevant bodies to be given statutory mandate to ensure effective and up to date collection of data and the imposition of standards to be followed by data producers so as to ensure data quality. It is also important for the government and institutions of higher learning to give adequate emphasis in formulating appropriate programmes to create awareness on the importance of data accuracy.

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